THE POPCORNS OF TURKEY

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The special significance of popcorns in the history of maize has been recognized by many students of that perennially fascinating problem (see, for instance, Sturtevant, 1894, Mangelsdorf, 1948). To scientists at large, however, the classification of popcorns and the description of the various ways in which they are used have been matters of such little moment that we were eventually driven to making our own world survey of popcorns and their uses (see Anderson and Cutler, 1950, for a general discussion). It was not until a decade of research had taught us to inquire in some of the most unlikely places that we learned (through Volney Jones) that popcorn is commonly used throughout Turkey and is a characteristic feature of many Turkish villages. At the very moment when we were endeavoring to have a comprehensive collection made for us there, Dr. Jack Harlan returned from that country with a collection of economic plants made for the Division of Plant Exploration and Introduction of the United States Department of Agriculture. Fifty-four collections of popcorn made by Dr. Harlan and his collaborators form the basis of the following report. We are indebted to Dr. Harlan for various observations supplementing the unusually complete data turned over to us by the Department of Agriculture, and to Dr. M. M. Hoover and his staff of the Regional Introduction Station at Ames, Iowa. It is a pleasure to acknowledge the efficiency and courtesy of this entire organization. We were welcomed to the increase plots in good weather and in bad, our attention was called to other collections of possible significance, and we were supplied promptly with viable seed of all the cultures we wanted to grow. For a few varieties of particular interest pertinent information was quickly produced from the files, and remnant seed of the original collections was made available to us.

The 54 Turkish popcorns collected by Dr. Harlan were grown in the experimental plots of the Pioneer Hi-Bred Corn Company at Johnston, Iowa, 20–30 plants being grown of each collection. A few varieties of particular interest were grown in replicate, and flint varieties and flint-dent mixtures from Dr. Harlan's collections were available for comparison in another plot. Each variety was scored for morphological uniformity, for season, for tassel type. Detailed measurements were taken on plant height, ear height, ear number, number of leaves above the ear, leaf length, leaf width, tassel exsertion, internode length and internode pattern, the width of the central spike of the tassel, glume length, the number of tertiary branches on the lowermost secondary branch of the tassel, the number of branchlets of the fourth order (if any), the number of secondary tassel branches, and the pubescence of the leaf sheath. At harvest time the plants were scored for husk number, for number of apparent nodes in the shank (the difference between these two numbers represents the number of condensed [telescoped] nodes of the

shank), shank length, shank width, kernel row number, kernel thickness, pith diameter, basal enlargement of the ear, pointing of the kernel, and color of pericarp and endosperm. At silking time regulation photographs of representative plants were made against a measured background. "Inclusive" herbarium specimens (Anderson, 1951) were made as a permanent record of each collection, each specimen including a photograph of the entire plant against a measured background and pressed central spikes and lower tassel branches.

Sporocytes of each culture were pickled in aceto-alcohol and smeared in the cytological laboratory. The number of chromosome knobs (a variable and diagnostic feature in maize—see, for instance, Mangelsdorf and Cameron, 1942) were determined and wherever possible knob positions were worked out. The results of these various measurements and scores are presented in Tables I and II. Photographs of representative plants are shown in pls. 5 and 6.

As soon as the collection began to tassel it was clear that maize is as heterogeneous a mixture in Turkey as are many other crops in that area (see Harlan, 1951). The variation within collections and between collections exceeded that in any of the collections of exotic maize from various parts of the world which we have had under observation. Three extreme types and three mixtures and intermediates between these extremes were apparent in the collection. One of these extremes was a popcorn identical with the variety known as Japanese Hull-less Popcorn. Since it came from Ankara, the capital city, and since most of the intermediates between it and the other two types came from the vicinity of Ankara or Istambul, the older capital, it probably represents a comparatively recent introduction into Turkey. It was strikingly different from the other two extremes. It had pubescent leaves, a heavy tassel with an extremely thick central spike, and the ear was elliptical in cross-section with a high number of rows of kernels, all of these features being characteristic of the variety Japanese Hull-less.

The other two extreme types were unlike popcorns commonly grown in the United States, and the two extremes, though connected by various intermediates, were quite unlike one another. One was very early to mature; the other was very late. The early type was short, with an exserted tassel, large glumes, and stiff upright tassel branches. Characteristically, the type had a low number of chromosome knobs, usually from none to three with either no knob on chromosome No. 6, or merely one small one. The late extreme was tall with numerous short internodes above the ear, which was borne high on the plant. The tassel was characterized by small glumes and lax branches, at maturity even the central spike remaining drooped over. The tassel was so included in the sheaths of the upper leaves that the lowest tassel branches were never completely free from the sheath of the uppermost leaf. Characteristically, it had seven to eight chromosome knobs, including two on chromosome No. 6 and one on No. 8. All these facts are set forth in the tables and the plates. Figures 1 and 2 show diagrammatically, but to scale, representative plants from the three most extreme collections of the two types.

The early extreme bears no close resemblance to any known race of maize though it is vaguely similar to several. It is rather like a somewhat degenerate form of the Northern Flint corns which were once characteristic of eastern North America. It is shorter and earlier than most of them, with somewhat smaller ears, higher row numbers on the average, and without the more or less enlarged base to the ear which is one of their most distinctive features.

The late extreme, on the other hand, belongs to a group of little-known popcorns with an intriguingly peculiar distribution. They are commonly grown by various aboriginal tribes along the borders of China and India; they were in early prehistoric times the prevailing type of maize on the coast of Peru and Chile; and they are still to be found here and there in various out-of-the-way places in South America. We received some years ago from Lorenzo Parodi, of Argentina, a popcorn of this general type and have a few scattered collections from Peru, Chile, and Colombia. Mangelsdorf and Oliver (1951) described and illustrated one from Caldas, Colombia. The collections from Turkey agreed with these Asiatic and South American popcorns in various technical characteristics of the inflorescence (see Alava, 1952)—in their knob numbers, the numerous ears high on the plant, the short upper internodes, and the drooping, included tassels. In its height, leaf shape, etc., the collection made by Harlan at Samsun was similar to varieties we have grown from the mountains of Siam, from the Naga tribes of Assam and from the Lushai Hills. Not only did it agree in general with these Oriental and ancient South American popcorns; with a popcorn collected in the mountains of Nepal (P.I. #166,162 called to our attention by Dr. Hoover), it was virtually identical. The collections from Nepal and from Turkey differed not as much as would two strains of any open-pollinated (i.e. non-hybrid) popcorn variety (such as Japanese Hull-less or South American) grown in the United States.

The three extreme types described above were apprehended by repeated study of the plants in the breeding plot. The exact association of characters was worked out more objectively by means of pictorialized scatter diagrams. One of these is presented in fig. 3. It has been set up to demonstrate the relationship for the seven characters which best differentiate the early flint-like popcorns from the late "Asiatic" extremes. As fig. 3 demonstrates, there is in the Turkish collections an over-all association for these seven characters, tassel exsertion, percentage of total height in the internodes above the ear, glume length, chromosome knob number, shank width, plant height, and ear height. At the upper right-hand corner of the diagram are the Asiatic extremes. As the diagram demonstrates, they are all plants with ears high on the plant, the internodes above the ears being proportionately short. They have narrow shanks, small glumes, and high knob numbers. At the lower left-hand corner of the diagram are the opposite extremes, a more variable lot. They tend to be short, low-eared plants, with exserted tassels and proportionately long internodes below the tassel. They have wide shanks, long glumes, and few or no knobs on their chromosomes. It will be seen that though the Asiatic extremes seem to be somewhat set off from the rest there is a gradual

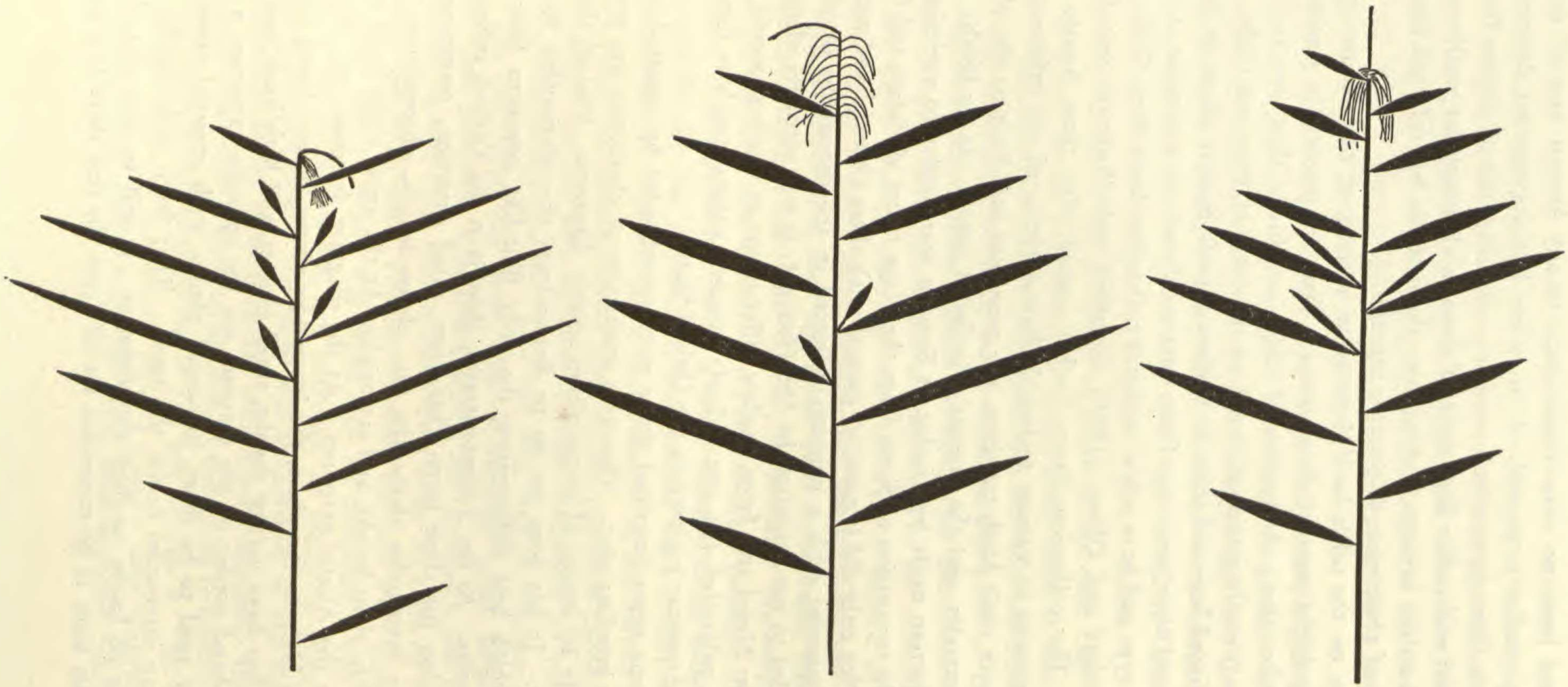

Fig. 1

Three examples of the "Asiatic" race of popcorn, highly diagrammatic but exactly to scale (× 1/25). The lengths of the internodes, of the leaves, of the shanks, and of the branches of the tassel are all to scale, and the shape of the tassel is copied from photographs of fully mature tassels. Each diagram represents a different collection. Note the short internodes, the drooping included tassels, and the multiple ears high on the plant.

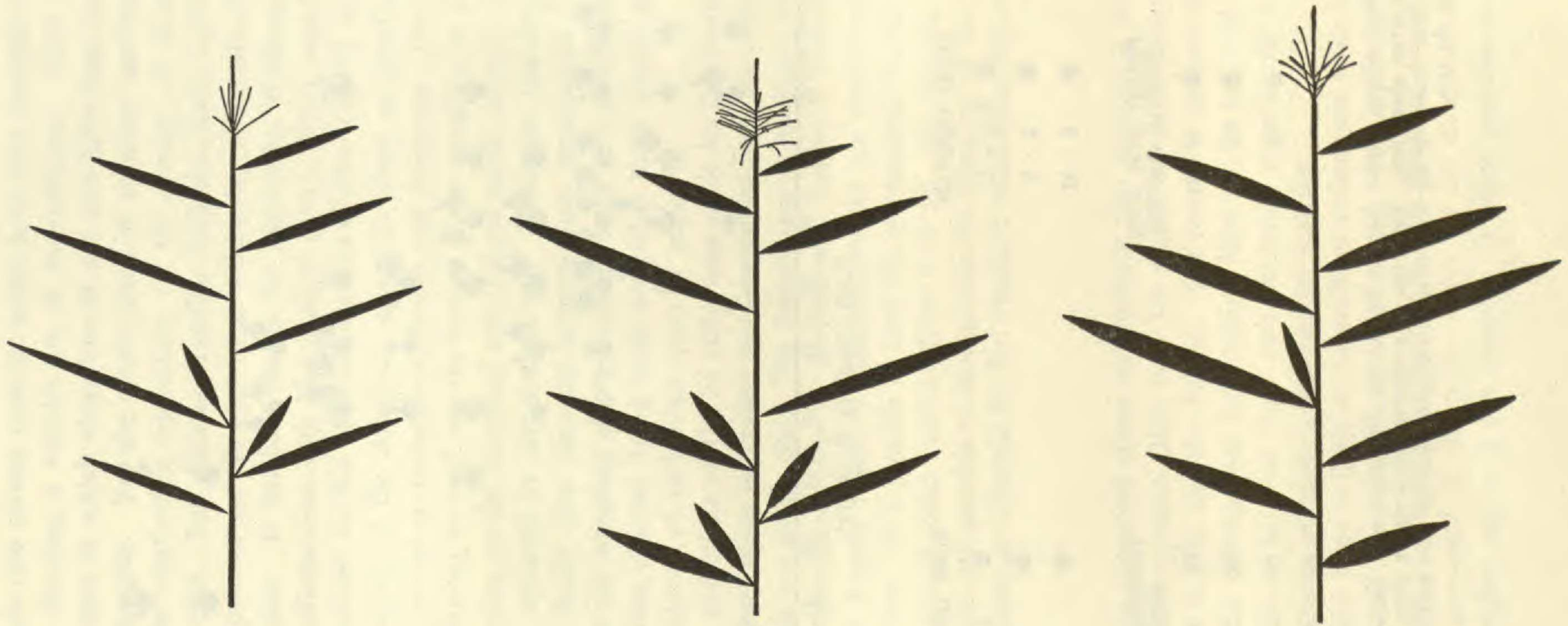

Fig. 2

Three examples of the "Aegean" race of popcorn, to the same scale and prepared in the same way as fig. 1. Note the exserted tassels, the longer internodes at the upper part of the plant, and the low ears.

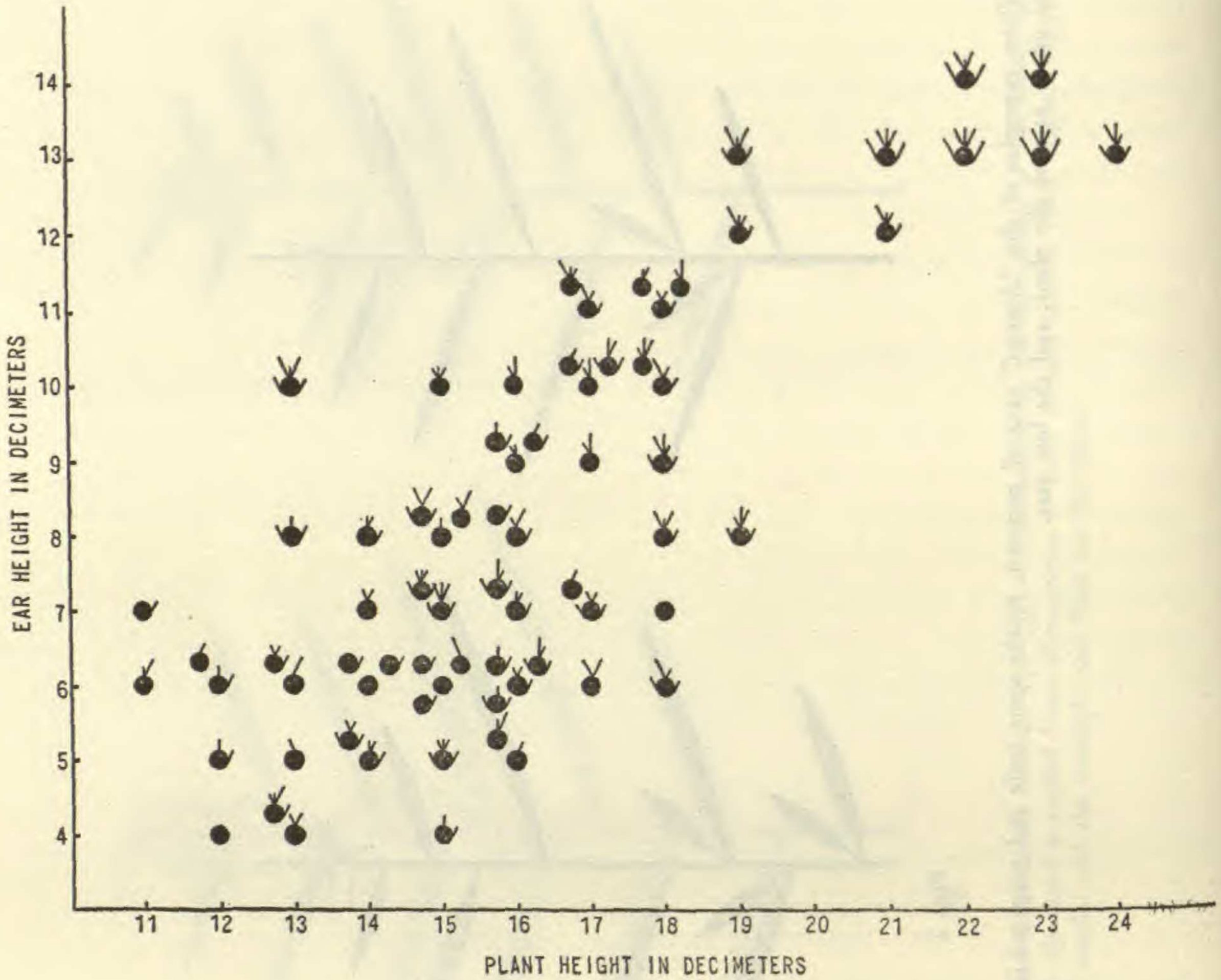

Fig. 3. Pictorialized scatter diagram illustrating the variation in Harlan's collection of Turkish popcorns for seven characters. Each dot is a diagram of a single plant for each collection, the plant having been chosen in the field as most representative for that particular collection. Further explanation in the text.

transition from one extreme to the other. The diagram presents an exact picture of the way in which two diverse races of maize have been brought together and have intermingled, forming a variable set of intermediates. Some of these are extreme recombinations in which characters of one race have been combined with characters from the other. For the whole group of varieties, however, there can be demonstrated the continuing association, *on the average*, of those characters which went in together. For those not familiar with the recent work on races of maize it should be pointed out that just such a mingling of correlated variables is characteristic of maize. It has been shown for Mexico by Wellhausen, Roberts, and Hernandez in collaboration with Mangelsdorf (1951, 1952), who have greatly extended the preliminary studies of Anderson and Cutler (1942) and Anderson (1946). For the maize of the American corn belt where purposeful mixing of two races has been carried on intensively, Brown and Anderson (1947) were able through these correlations to work out the history of the mingling by these indirect methods before carrying on the historical and archaeological research which proved that it had indeed occurred in just such a way (Anderson and Brown, 1952). There can be little doubt then that the heterogeneous popcorns of Turkey were largely derived from the mingling of popcorns from the two widely different races of maize, the resulting mixture being made somewhat more diverse by the comparatively recent addition of still other types of popcorn.

After the racial affiliations of the 54 collections made by Dr. Harlan had been worked out, their distribution in Turkey was determined from his collecting notes. The resulting picture is a simple one. The Asiatic race in its purest form is characteristic of the mountainous areas in northeastern Turkey. The other race is characteristic of the Aegean shores of Anatolia and we are accordingly referring to it as the Aegean race. It is possible to turn the pictorialized scatter diagram of fig. 3 into a crude sort of index running from 0 to 14. By plotting these index numbers in four grades it is possible to demonstrate the mingling of the Aegean and Asiatic races of popcorn as reflected by Dr. Harlan's collections (fig. 4).

Conclusions:

From the evidence presented above we conclude that popcorn is widespread in Turkey. Though heterogeneous there even for maize, it can be assigned to two provisional races, the Aegean and the Asiatic. The former is commonest along the coast, the latter in the northeastern mountains. Most of the popcorns of Turkey are various intermediates between these two extremes, occasionally modified by more recent introductions of modern commercial varieties.

In the above report there is little or no evidence to indicate when or where or by whom these popcorns were introduced into Turkey. To answer such questions we have begun a series of ethnological, linguistic, and historical inquiries. These investigations have proceeded to the point where we are confident that though the problem is a complex one, it is not chaotic. It seems probable to us, in the

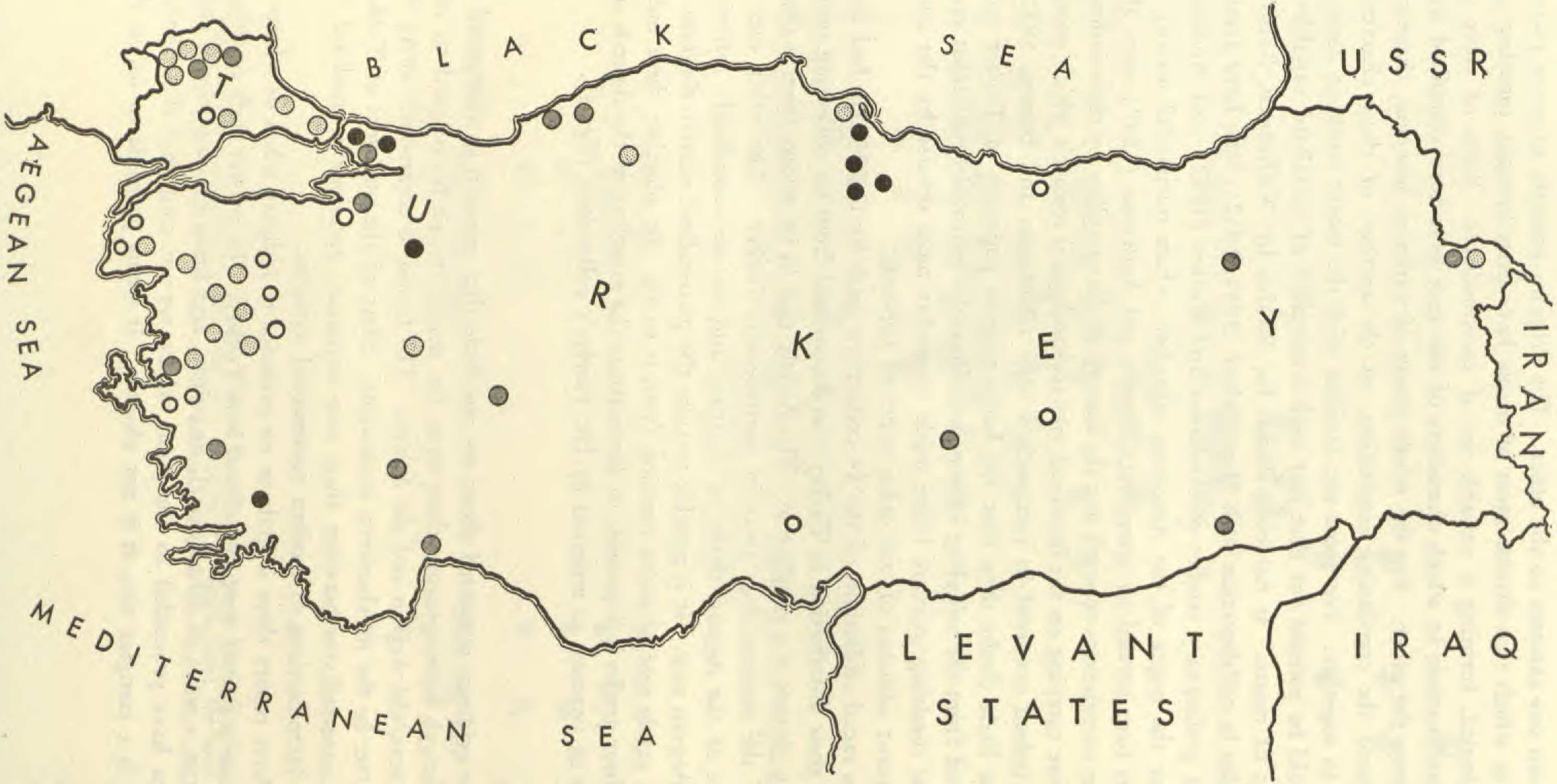

Fig. 4. Distribution of the original collections made by Dr. Harlan and diagrammed in fig. 3. The numerous collections in and around Ankara, the capitol city, have been omitted. The values of fig. 3 have been turned into a crude index running from 0 for typical "Aegean" varieties to 14 for typical "Asiatic" varieties. Solid black dots represent collections most like the Asiatic extreme (those in the upper right-hand corner of fig. 3); open circles, the most extreme Aegean types; lightly stippled dots, intermediates resembling Aegean; heavily stippled dots, intermediates resembling Asiatic race.

light of all the evidence, that the Asiatic and the Aegean popcorns were brought to Turkey at different times, and by different routes. Further discussion must be postponed until other evidence can be presented.

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